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ON THE APPLICATION OF POTATOES TO THE MANUFACTURE OF SUGAR AND SPIRITS.[*]

(Concluded from No. II. page 235.)

Before M. Dubrunfaut proceeds to state his proposed improvements in malting, and fermentation, he describes the following process at present pursued in Paris, as preparatory to his own.

“ *Method of obtaining Potato Starch for distillation.*—

“ This process consists of two operations: 1st. grating the potato; 2nd. separating the starch. Sometimes, when the distiller does not prepare his own starch, but buys it ready made, 'tis necessary to submit it to the additional operation of draining, (*égouttage.*)

“ The grating has for its object, to break up the vegetable fibres which enclose the starch in their tissue: the finer these fibres are torn, the more starch will be liberated and obtained.

“ The first instrument employed, was a grater of sheet tin; afterwards, cylinders of a large diameter on the same principle, were constructed, in which the tin was replaced by sheet-iron; but a machine of this material could not possess much stability, and the burrs punched in the plate, soon wore away. In forming new ones, the holes were enlarged and the instrument thus became so deteriorated, that it frequently required to be renewed.

“ Various machines were constructed with a view to combine solidity, durability and expedition. Of these, Burette's[†] grater appears to be the best, though it still leaves much to be desired towards a more perfect division of the pulp of the potato. The Royal Society of Agriculture at Paris, convinced of the utility of possessing the means of thoroughly extracting the starch, offered a premium some years ago for its discovery.”

In the 31st vol. of the Trans. of the Society for the encouragement of Arts &c. London, is given a description of a machine for obtaining potato starch, invented by Mr. John Whately of Cork, in the year 1813, for which he obtained the Society's lesser gold medal. The Repertory of Arts, &c. 1814, vol. 25, p. 329, second series, also contains explanatory details and drawings of the apparatus, together with a transcript of Mr. Whateley's interesting communications on the application of potato starch, as an *improvement* in the fabrication of bread and biscuit. This machine was calculated to grind or grate 15 cwt. of potatoes, by the work of one man in one day, into soft pulp, yielding about 2 cwt. of starch when dried, and if worked by a horse, to grind 22 tons of potatoes per week.

A member of the Royal Dublin Society who has himself used Mr. Whately's machine, speaks of it in high terms.

This apparatus is of a very simple construction. Its moving part consists of a cylinder covered with sheet tin or iron plates, pierced with holes to produce a rough surface similar to that of the graters used for nutmegs, &c., but the holes in this are larger. The cylinder is situated beneath a hopper, into which the potatoes are thrown, and thence admitted into a kind of trough where they are *forced* against the side of the cylinder, which in revolving, reduces the potatoes to pulp.

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[*] Review of Dubrunfaut's *Traité complet de l'art de la Distillation*, &c. 2 vols. 8vo. Paris. By E. B. Stephens, Chemical Assistant to the Royal Dublin Society.

[†] “ A strong frame of oak, of an oblong form, mounted on feet and strengthened above and below by cross pieces, supports the moving ports of the machinery. A solid cylinder of wood, 18 inches diameter, snd 8 inches long, is armed on its circumference with 80 knife blades, 7 inches long. The axis of the cylinder carries at one extremity an iron pinion with 16 teeth, which plays in another of 120 teeth, that bears handles of 18 inches radius on the ends of its axle. Under this cylinder is placed a shoot, inclined so as to convey the pulp obtained, into a trough. Over the same side of the frame and in front of the circumference of the cylinder, a wooden valve is adjusted on a moveable centre, which receives a motion (back and forward) from the axle of the pinion, by the aid of a crank, so that the space between the cylinder and this valve, for the passage of the potatoes, is alternately shut and open.

“ The machinery is covered over by a wooden case, surmounted in front by a hopper, holding nearly a quintal of potatoes (1 cwt. 3 qrs. 24½ lbs. avoir.) This grater worked by two men, will reduce 2500 kilogrammes (40 cwt. 0 qrs. 22 lb. avoir.) in 12 hours. It costs 400 francs. Made by *M. Burette, Rue des Vinaigres, Paris.*” Vide, Report of *M. Pajot-Descharmes* from the committee of *Arts mechaniques to the Société d'Encouragement, &c.*

There is some ingenuity displayed in the construction of this trough, and the movements allotted to it. It extends along the entire length of the cylinder so closely, as only to allow space for the pulp produced to pass, and is furnished with a moveable back, formed by a concave board which is alternately pulled backward to create space for each charge of potatoes from the hopper above, and pushed forward to press them into effectual contact with the revolving grater. The back-board acts in fact like the human hand on a large scale, or rather like a number of hands co-operating, for its surface is perforated with circular holes, (something less in diameter than an ordinary sized potato) which serve to *hold firmly* at the same time that they *push forward* the crowd of potatoes that would otherwise acquire a rolling and evasive motion. This back-board is governed by a simple crank-lever, from the end of which, a weight suspended on a hook gives the necessary impelling pressure ;—a line tied to the same weight, passing over a pulley, hangs down within reach of the operator; by drawing this line, the weight and lever are raised up ; the board is pulled back to the outer edge of the trough, a fresh charge of potatoes falls into it from the hopper, and the line being let go, the weight and crank again push forward the back-board with its mimic *handsful* of potatoes, and so the work proceeds; the pulp being carried by the descending surface of the cylinder out of the trough, the instant it is produced, and falling into a receiver beneath. The washing &c. is performed as usual.

The principle of this instrument is unexceptionable; in practice it is highly approved of, and as greater strength and expedition may be kept in view in any modern construction on Mr. Whately's plan, those who might be delayed or discouraged by the idea of the necessity of sending to Paris for their machinery, need not dread any obstacle to the preparation of potato starch on the score of apparatus.

" The potatoes to be grated, are thrown by a woman or a child into the hopper of the machine; two men turn the handles, and in ten hours" (the report of the Committee says 12 hours) "reduce 2500 kils. The pulp falls into a receiver under the cylinder, and is immediately carried away to be submitted to the following operation.

" *Separation of the Starch.*

" A large sieve of horse hair, two feet in diameter and one foot in height, is charged with a quantity of pulp nearly equal to two thirds of its capacity, and placed on two bars across the mouth of the vat. A man works this pulp strongly with his hands, while a jet of water is thrown on it, proportioned to the dimensions of the sieve. For one, two feet wide and one foot high, the jet should come from a pipe from four to five millimètres in diameter (0.16 to 0.20 of an inch.) This water, aided by the movement given by the hands of the workman, penetrates the pulp, and runs off through the sieve, carrying the starch with it into the vat beneath. This manipulation is continued till the water passes quite clear through the pulp, which is then thrown aside for the feeding of cattle, and replaced by a fresh quantity, to be deprived of its starch in the same manner.

" By this process, about 750 kils. (14cwt. 3qrs. 1lb.) of wet starch, (*fécule verte*) are obtained from 2500 kils. (49cwt. 0qrs. 22lb.) of good potatoes. These 750 kils. of wet starch are equal to 500 kils. (9cwt. 3qrs. 10lbs.) dry. That is to say, 3 parts of wet starch produce 2 of the dry. Above 13 hects. (289gals. imp.) of pulp are obtained, which retain very nearly the same quantity of water that the crude potatoes do, that is ¾ of their weight; so that 13 hects. contain nearly 975 litres of water (215 gals. imp.) The pulp in this state, may be given to cattle, but it is not nearly so good as that which is the residue of the distillation from the entire mass in the old method, which is boiled in the process, and found to be very nourishing. It is easy, however, to obviate this inconvenience in a distillery where the pulp may be cooked with boiling wash furnished by the still.

"I have seen a better arrangement of the sieve, than that I have described, which deserves to be mentioned here. It consists in filling with water to within a few inches of the top, the vat intended for the reception of the starch. The sieve charged with pulp is suspended in this vessel by cords *beneath* the surface of the water, and a workman agitates the mass with his hands, till all the starch falls through the meshes of the sieve, and re-unites by its own weight at the bottom of the vat. When this operation is performed, the sieve is raised, and a small portion of water thrown on the pulp, is sufficient to clear it completely of starch.

"The starch separated from the pulp in either of the above methods, after about an hour's repose, (when the vessel is not more than 60 to 70 centimetres high (24 to 28 inches) is taken from the bottom where it is found in a thick and nearly solid stratum. The superincumbent water is first drawn off by cocks in the side of the vat, till its surface is lowered almost to the surface of starch. If it is wished to obtain it dry, in pieces or lumps, an additional process is adopted.

"A draining apparatus (*égouttoir*) is set up of the following construction. A wooden trough or box open at top, and widening conically towards the mouth, is pierced all over the bottom and sides with a number of small holes, and lined inside with a strong linen or hempen cloth of a very compact texture. It is mounted on a vessel to receive the water that drops through during the operation, and is then filled with the starch as it is taken from the vat. In the course of 24 hours, the starch loses its superabundant water, and presents the appearance of a mass still humid, but yet sufficiently solid to bear removal without losing its shape.

"When the starch is sufficiently drained, two men overturn the trough on a table, throw out the starch, and break it in pieces of a manageable size. This process is only necessary when the distillery happens to be separate from the starch factory. They operate thus in Paris for instance, where the distillers buy their starch from the makers.

"By these operations from 18 to 20 per cent. of dry starch is obtained from good potatoes, or what is equivalent, 27 to 30 per cent. of wet. In manufacturing on the large scale, no more than this can be expected, for the grating is not complete enough to liberate the quantity obtained by chemical analysis."

M. Dubrunfaut proposes to operate on the starch thus freed from pulp in either of the two following modes, thereby avoiding the peculiar difficulties of the ordinary process.

"*First Modification.*

"For a charge of 11 hectolitres, (242 gals. 3 pts. imp.) 80 to 85 kils. (176 lbs. to 187 lbs. avoir.) of wet starch, or ⅔ of this amount of dry, are taken, or still better, the product of 400 kils. (7 cwt. 3 qrs. 12 lb.) of good potatoes. This is thrown into a vat, and mixed with nearly twice its weight of water, which will be about 200 litres (44 gals. imp.) into a thin even fluid, like milk. To effect this, the mixture must be carefully stirred all the time by two men with rakes, because the starch being heavier than the water, would, without this precaution, settle down to the bottom in a layer, very difficult to manage. It is necessary for the success of the ensuing operation, that the starch should be freely suspended in the water."

The author also recommends the use of machinery for this purpose, as being much more certain and uniform in its action. His plates and descriptions almost apply to the ordinary traversing machinery-rake of our breweries and distilleries.

"All being thus disposed, and having established a motion in the vat to maintain the mixture in a proper state of fluidity, from 500 to 600 litres (110 to 132 gals. imp.) of boiling water are gradually added. The entire now becomes thick, and is converted into a paste or jelly (*empois.*) This jelly at first assumes a milky aspect, but when the 600 litres of boiling water are completely blended, it becomes remarkably transparent.

"At this period, the starch is in a proper state for undergoing the saccharine change, and from 20 to 25 kils. (44lbs. to 55lbs. avoir.) of malt, previously softened by steeping, are added. Here the peculiar action of the malt is as manifest as in the case of rice, and in ten minutes it forms a perfect mixture with the jelly, that is to say, it is completely liquified. It is then left at rest for three or four hours (as in the maceration of corn,) during which time the liquid acquires a sensibly saccharine taste. To prepare it for fermentation, it requires to be further diluted with water, till the entire volume of 11 hect. is made up.

"It may be useful to observe, that the malt employed ought to be ground fine: its action on the starch is then more prompt and energetic.

"The wort obtained by this process, and with the proportions of materials above specified, marks about 5° on the areometre. (1035 sp. gr.) A litre (1¾ pint Imp.) of good barm suffices to put 12 hect. (264 gals. 3 pints, Imp.) of wort in fermentation.

"It is easy to perceive the advantage which this mode of operating has over that generally used: the fermented product is perfectly fluid, with the exception of a slight deposit formed by the insoluble portions of the malt and the barm.

Second Modification—"This process has for its object to avoid the manipulation necessary in separating the starch from the pulp:—From ten to twelve kilogrammes (22lbs. to 24⅗lbs. avoir.) of short straw or chaff are spread evenly over the false bottom of a vat of about 8 hects. (176¼ gals. Imp.) capacity: on this is laid the crude pulp of 400 kilogrammes of potatoes as they come from the grating machine. This pulp is allowed to remain untouched here from fifteen to thirty minutes, during which time a portion of its water of vegetation drains through the false bottom, and is drawn off by a cock beneath.* Two workmen then armed with rakes or oars, (as in the English method of mashing corn,) continually stir the mass during the addition of from 400 to 500 litres, (88 to 110 gals. Imp.) of boiling water; the mixture at this period is thickened by the conversion of the starch into jelly: the maceration is then commenced by the addition of 25 kilogrammes of fine ground malt previously soaked, and after agitating sufficiently, it is left at rest for three or four hours. All the liquid which filters through the false bottom during this time, is drawn off by the cock, and conducted to the fermenting vat, which should, as in the former process, be capable of holding 11 hects. The mass is allowed to drain a quarter of an hour longer, and the liquid is drawn off as before. A second quantity of boiling water is then added, amounting to 2 hects. (44 gals. Imp.) the mass is stirred anew, then left to drain, and the liquid obtained again run off to the fermenting vat.

"This treatment cools the liquid product considerably; but to thoroughly cool and exhaust the pulp of all the fermentable matter which it may still contain, from 2 to 3 hects. of cold water are thrown over it, which on draining through, is received into the fermenting vat with the former liquid extracts.

"By operating in this manner, the pulp which remains on the false bottom, is sufficiently exhausted; it still retains, however, an hour after it ceases to drain, nearly three-fourths of its weight of a liquid weakly charged with fermentable matter; but this need never go to waste in a distillery properly managed, where the refuse is allotted to the feeding of cattle. However, if it be deemed advisable to perfectly exhaust the pulp of its liquid, this may be effected by passing it once through the cylindrical press formerly described. In this way, a liquid amounting to nearly half the weight of the wet pulp can be expressed; but simple drainage is sufficient; and this practice of pressing the residue, is not at all necessary where the full quantity of water that I have recommended is used in maceration.

"In such a routine of operations, the fermentable liquid is gradually cooled, till at the end of the process it acquires a temperature very suitable to the commencement of fermentation, and a gravity of about 5°." (1035 sp. gr.)

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* In the summer of 1822, during a course of experiments made on potato starch in the Laboratory of the Royal Dublin Society, a considerable portion of this water of vegetation was collected and examined. On being carefully evaporated to an extract, it gave out a strong odour of hemlock, and its narcotic powers were put to the test by two amateurs the same evening: one who swallowed three grains of the recently prepared extract at the Laboratory, went home across the city and fell asleep on the stairs leading to his apartments; he was put to bed, and forcibly wakened next day after twenty-one hours continuous sleep, by his anxious friends who could not account for his prolonged drowsiness. The other took three and a-half grains, and fell asleep on his chair before he could undress; his slumber continued unbroken for eighteen hours, when he was aroused by an accidental visitor: no other peculiar symptoms were experienced.

Thus it appears that they have in France three methods of macerating, or inducing the saccharine change in potatoes. Both of Dubrunfaut's modifications are much superior to the old mode* in which an extra expense of fuel is incurred in cooking by steam; a larger Still with machinery to agitate the bulky pulp during distillation is required, and a spirit more or less empyreumatic is obtained from the unmanageable *pâte* that frequently adheres to the bottom of the Still during the process, despite of its rotary scrapers, creating a necessity for repairs, &c. In the modification introduced by our author, an economy of fuel is suggested that is worthy of attention: thus, a portion of the spent wash that is discharged from the Still at a boiling heat, will serve very well instead of fresh water to macerate either the pulp or the separated starch. But the chief advantages consist in the safe and easy distillation of a well-fermented *clear liquid*, without any necessity of taking the precaution to agitate or cool the contents of the Still during the operation; and finally, the production of a spirit of a superior flavour. All potato spirit in its fresh state retains a perceptible taste of the root that is not very agreeable; but this is easily removed by rectification.

Of the two improved methods, M. Dubrunfaut decidedly prefers the latter; he states, that it yields on an average 50 to 55 litres, (11 to 12 gals. Imp.) of spirit at 19° (935° sp. gr.) from 100 kilogrammes (220lb. avoir.) of potatoes.

Our author proceeds to detail the most improved process of the present day, for the

Conversion of Starch into Syrup, by the action of Sulphuric Acid; a discovery made by the celebrated Russian chemist, Kirchoff, in 1811. His process was as follows:—

"Take 2 kilogrammes ($4\frac{2}{5}$lb. avoir.) of starch, and diffuse it through 8 kilogrammes ($17\frac{3}{5}$lb. avoir.) of water, sharpened with 40 grammes (617 grains) of sulphuric acid at 66° Baumé, (oil of vitriol of commerce, sp. gr. 1848°·) and boil the mixture for thirty-six hours in a leaden or silver vessel, taking care to stir it carefully with a wooden spatula during the first hour's boil, to prevent its setting in lumps to the bottom. At the end of this hour, the mixture becomes almost entirely fluid, and only requires stirring at intervals: according as the water evaporates, it ought to be replaced. When the liquid is sufficiently boiled, chalk is added to it in powder, to saturate the sulphuric acid: on being left to cool and settle, it is found to possess a decided sweet and very agreeable taste; being clarified and evaporated to a syrupy consistence, it acquires an intense saccharine flavour, and yields on cooling, crystals of sugar.

"Kirchoff, in this process employed the starch of commerce, and on its publication, many chemists employed themselves in verifying and improving it. M. Vogel at Paris, M. Lampadius, and M.M. Ittner and Keller at Fribourgh, with many others, published in the year 1812, the results of their experiments. Lampadius substituted the starch of potatoes for that of wheat, and altered the process of Kirchoff in other respects, for instead of boiling the mixture of starch and acid in a basin of lead, silver, or tinned copper, (a mode attended with several inconveniences,) he operated on it in a wooden vessel heated by *steam*, raised in a separate boiler and conducted to the bottom of the mixture by a pipe descending perpendicularly. This improvement was the origin of the art which since has been so usefully applied in France, in the manufacture of spirit from potatoes. Up to this time, no other process was known than that of boiling whole potatoes by water or steam, and macerating them by malt: a mode highly inconvenient, from the necessity of introducing solid materials into the still. The hope afforded by the new method of avoiding this, and likewise of producing a spirit of better flavour, stimulated the activity of manufacturers and men of science so effectually, that in the present day, the art of saccharizing starch by sulphuric acid is become a regular branch of manufacture, very simple and practicable."

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* Vide National Magazine for August last, p. 234.

Our author proceeds to describe the most improved apparatus, and the process now adopted in Paris in the transformation of potato starch to sugar, (and finally to spirit,) on the principles developed by Kirchoff and Lampadius :—

" The capacity of the vat of this apparatus is 20 hect. (440½ gals. Imp.) and 300 kil. (5 cwt. 3qr. 16lbs.) of starch can be acted on, at a time, in it. The routine of the operation is as follows :—600 litres (132 gals. Imp.) of water are thrown into this vat, and heated by steam from the boiler as nearly as possible to the boiling point. In the mean time, 300 kil. of starch are mixed, in a separate vat, with 600 kil. of water and 6 kil. (13⅕lbs. Av.) of the strong sulphuric acid of commerce. This mixture is then thrown, little by little, with constant stirring, into the vat of hot water, where it is instantly converted into thick paste, which however is speedily liquified by the sulphuric acid that it carries with it. It is essential to the success of this operation *not* to throw in the mixture all at once. The most approved mode is to divide it into three equal parts to be added at three several times. The first portion is thrown in, as I have said, when the water arrives at about the boiling temperature, taking care to agitate incessantly and continue the steam heat. The paste is rendered liquid by contact with the acid, and the temperature which was at first lowered by the charge of the cold mixture, is quickly raised to 80° R. (212 F.) At this epoch, the second portion of the acidulated starch is thrown in, and agitated ;—again the temperature is lowered, the mass becomes thickened by the formation of paste, and finally liquified by the action of the acid as the heat is raised anew by the steam. When the temperature approaches 75° R. or thereabouts (200° F.) the last portion of starch and acid is thrown in and agitated as before : the same effects are re-produced, and the heat is continued till the entire vat acquires the boiling temperature.

" At this crisis, the trap-door of the vat is carefully closed, (and even luted if it does not shut very tight,) when the vat is left to itself for about six hours. It is during this repose that the saccharine change in the starch ought to take place, and it requires not only the presence of sulphuric acid, but also of a temperature maintained constantly to 80° R. (212° Fah.) To effect this, it was the practice (at the commencement of this branch of industry) to continue the introduction of steam during the six hours ; but it has since been clearly proved that this continued ebullition is useless, and that it suffices to preserve the heat (by close covering above) to obtain a good result. It may easily be conceived how superior this latter arrangement is, which economises the fuel necessary to maintain a steam-boiler in ebullition during six hours.

" I have recommended the employment of 6 kil. of acid for 300 kil. of starch, which amounts to just 2 per cent. This proportion of acid may be augmented, as has been recommended by Saussure, without prejudice to the success of the operation. This chemist has observed that the saccharization is always more decisive and complete when the dose of acid is greatest. The proportion of 2 per cent. is, however, convenient and fully sufficient, for the use of more would not abridge the term of six hours that is necessary for its repose.

" The method (the only one) of ascertaining whether the saccharization is complete, and whether any portion of the starch has escaped this transformation, consists in the assay of the liquor by iodine, which has the property of colouring starch, either in suspension in water, or in solution in the state of paste, to blue or violet. By the aid of this re-agent, the various stages of the saccharization of the starch can be clearly ascertained. If a sample of the liquor be taken from the vat at the period when it is proper to leave it to repose, and mixed in a glass with a drop of solution of iodine, it will assume a strong blue colour. The liquor (from the vat) treated, in two or three hours after, in the same manner, will be coloured much less ;—and a sample taken after six hours repose, at the temperature of 80° R. will no longer exhibit any change of colour. This is the test of the full saccharization of the liquor, indicating that it is time to proceed to other operations.

" The door of the vat is now opened, and the neutralization of the sulphuric acid commenced. This acid is, in fact, not at all decomposed in the operation, and at the conclusion, is found in the liquor in the same state it was at the beginning. To get rid of it, a substance must be introduced capable of forming with it an insoluble compound. Such a one is lime, or still better, carbonate of lime, (chalk or whiting) which can be always procured.

" If lime be employed, care should be taken to add the precise quantity necessary, because a dose greater or less would be equally injurious to the fermentation. This danger is avoided by the use of carbonate of lime, which may, without inconvenience, be employed in excess. To neutralize the 6 kil. of acid engaged in the process, nearly 10 kil. (12lb. Av.) of chalk or whiting in fine powder are required. This powder is mixed with two or three times its weight of water, and thrown gradually into the saccharine vat, the contents of which are kept in motion by an agitator. At the instant the earthy carbonate comes in contact with the acid, a great effervescence is excited, caused by the disengagement of the carbonic acid gas which bursts up through the surface. The powdered chalk must still be added till it no longer produces any effervescence in the liquor. This point of saturation ought to be attained when (as I have said,) 10 kil. of chalk for every 6 kil. of acid have been added. If this quantity does not suffice, more must be thrown in. Test paper (tinged with syrup of violets or of turnsole) may be employed to indicate the moment when the liquid is saturated; that is to say, the moment when the additions of chalk should cease. The tints of violets and of turnsole are changed to red by the presence of acids; papers coloured by these plants, continually dipped into the vat, will discover the instant that the acid disappears completely, thus showing also that sufficient chalk has been added. This precaution is not attended to in the manufactories, for the workmen fear no bad result from an over dose of chalk, and indeed always employ it in excess. They judge of the point of saturation entirely by the eye, watching the effervescence till its termination.

" I shall not enlarge on this operation, which is founded on well-known chemical affinities; suffice it to say, that the carbonate of lime is decomposed by the sulphuric acid: its carbonic acid is disengaged in the state of gas, while the lime combines with the sulphuric acid to form sulphate of lime, (gypsum or selenite) which being insoluble, is precipitated to the bottom of the vat in a solid state, together with the carbonate of lime employed in excess, which is also insoluble.

" The neutralization of the sulphuric acid being effected, the liquid is again left at rest from half an hour to an hour. It is no longer of any consequence to preserve the heat, as in the repose necessary to saccharization. The settlement of the new formed sulphate of lime is now the only object to be attained, and this generally occurs in less than an hour.

" The vat is furnished with two cocks, one on a level with the bottom, the other three or four centimetres ($1\frac{2}{10}$ to $1\frac{6}{10}$ inches) above. This latter is opened to ascertain that the precipitation is complete, which is indicated by the transparency of the liquid that flows from it. This clear liquor is completely drawn off, and conducted to the fermenting vats. The residual deposit is then withdrawn by the lower cock, and thrown to drain on a strong hempen cloth of a close texture. The liquid that filters through, is added to the former.

" The wort now possesses a density of 9° Baumé (sp. gr. 1065°) at which strength many distillers commence the fermentation; waiting, however, till it cools to the temperature of from 20° to 25° R. (77° to 88° Fah.) before they add the barm.

" I have do doubt that it would be more advantageous to dilute this wort previous to fermentation, to 5° or 6° Baumé (1035° to 1042° sp. gr.) by the addition of cold water, which will simultaneously establish the requisite temperature, and avoid the inconvenience of leaving the liquor to cool unassisted to the proper temperature. The fermentation will thus be completed more quickly—more alcohol will be obtained—less acetic acid formed, and then the spent wash may be employed boiling hot from the still, (instead of water) for new saccharizing operations.

" In Paris, from 20 to 25 litres (4 gal. 3¾ pt, to 5½ gal. Imp.) of spirit at 19° (935° spec. grav.) is the ordinary produce obtained from 50 kil. (110lbs Av.) of starch saccharized by sulphuric acid. Every thing induces me to believe that this produce can be considerably augmented by the practices I recommend, that is to say, by diluting and cooling the wort at once without loss of time, and also employing the boiling wash in new fermentations.

" We may clearly perceive that the quantity of alcohol obtained up to the present day, is merely an approximation to the true theoretic result. Suppose that we operate on 100 kil. of starch by sulphuric acid, and that we otain 50 litres of spirit at 935° sp. gr.; each litre weighs therefore 935 grammes; total 50 × 935, that is to say. 46,750 grammes. By the table of specific gravities we find that this quantity of spirit contains of

Alcohol, pure - -	12,375	grammes.
Water, - - -	34,375	do.
	46,750	do.

We then obtain, it appears, from 100 kil. (or 100,000 grammes) of starch, 12,375 grammes of alcohol.

"We know that starch acted on by sulphuric acid produces *an equal weight* of sugar; we know that sugar in fermentation gives nearly half its weight of carbonic acid gas, and the other half of pure alcohol; now 100,000 grammes of starch, if we could operate with mathematical exactness, should yield 50,000 grammes of pure alcohol! Compare this with the actual result, and it will be perceived that we do not realize a quarter of the theoretic quantity.

"All that has been accomplished only proves that we have yet much to do towards perfecting the process for transforming starch into alcohol."

This is a very deficient produce compared with what is obtained throughout Great Britain and Ireland, in the ordinary grain fermentations. It is calculated by Dr. Thomson that ⅘ of the saccharine matter of our wort is converted into alcohol.* The loss of ⅕ is however a serious deficiency, considering the immense value of corn annually consumed in the three kingdoms in the manufacture of spirit. He supposes that it is chiefly lost in evaporation during the brewing process.

The greatest produce I have heard of being obtained in our distilleries was 9-904 English gallons from the barrel of corn. As this quantity is singularly great, and a reference may be desirable, I give my authorities in an extract of the original document from which I take my information.

"I certify that Mr. William Egan brewed at my distillery nine hundred and thirty-five barrels of corn, (twelve stone per barrel) which produced nine thousand two hundred and ninety-seven gallons of proof spirit, English measure.

"Sligo, August 2, 1825. ABRAHAM MARTIN."

The fermentation of potatoes for distillation is not a novel application. Nearly sixty years since, brandy was distilled from them in Sweden. There is a record of the process in the Swedish Transactions, in which "sixteen measures of potatoes were boiled with water, and worked with the liquor, till the whole became a tough dough: this was diluted with boiling water to the consistence of thin gruel, and fermented. The fermentation went on well, and the liquor distilled on the third day yielded one measure of good brandy."

In the year 1820, an improvement in the distillation of potato brandy was introduced into Sweden by M. Siemen, of Pyrmont, who was invited to Stockholm by the government, at the instance of M. Berzelius. The Danish government also induced him to visit Copenhagen the same season, and communicate his process to Professor Oersted, who expresses his approbation of it in high terms. As M. Dubrunfaut does not notice it, a short account may be acceptable.

The potatoes are *heated by high pressure steam* above the temperature of 212 ° F. They are then *reduced to a fine pulp*, by the rotary motion of an iron cross in the vessel where they are steamed. This pulp is then diluted with hot water, and a little caustic potash;

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* Supplement to Encyclopædia Britannica. Article, Brewing.

one pound of potash is sufficient for three or four tons of potatoes. The effect of the high steam heat is to render the pulp extremely miscible with the alkaline water, so that every thing except the skins readily passes through a sieve. This fine pulp is then *speedily cooled*, (which appears to be essential to the process,) and is then fit to be fermented by the ordinary mode. A great quantity of yeast is also produced during its fermentation, which serves either for future operations, or for bakers' use. M. Siemen states the product of spirit by his process to be more than one-third greater than in the common one, which amounts to thirteen quarts from a ton of potatoes. In the experiments made under the eye of Professor Oersted at Copenhagen, from sixteen and a half to seventeen quarts of spirit, at 50° of Tralles' alcoholometer were obtained from a ton of potatoes, making a fair allowance for that portion of the product due to the malt used in the maceration. This spirit is stated to have a finer taste than that obtained from grain, but the produce is trifling compared to the French.

In an article in De Thaer's Annals of Agriculture, M. Müller asserts that an apparatus on Siemen's principle, costing from two hundred to two hundred and fifty Prussian dollars, is capable of producing fifty per cent. more spirit from potatoes, than the apparatus generally used in Germany. Calculating from the price and produce of potatoes and rye in 1820, M. Müller declares that one hundred tons of the former converted into spirit, would produce a profit of from five hundred to six hundred rix-dollars, while the same space of ground that produced them, if sown with rye, would not give more than ten to twelve rix-dollars.

Improvements have also been effected in this branch of distillation in Russian Poland, by Tœnnius of Slomin, who procures pure alcohol at one distillation, entirely free from empyreuma, and fit for the finest *liqueurs*. The peculiarities of his process are not stated.

During the last year Mr. Jameson, of Fairfield, near Enniscorthy, commenced distilling whiskey from potatoes. They were sliced, dried on a corn-kiln, ground to flour, mixed in certain proportion with corn, and mashed in the ordinary manner as if corn had been treated alone. But the peasantry of the county of Wexford, who were then largely engaged in the culture of tobacco, to the great neglect of their potato crops, and were obliged to buy their ordinary supply of the latter, and at a high price, complained so much of the increased consumption, that the process was relinquished.

In a paper presented to the Royal Society of Agriculture in Paris, 1823, M. Dubrunfaut details some experiments by which it appears that potato starch macerated according to a method parallel to his "*first modification*," and afterwards treated with hops, and fermented, makes an excellent beverage, much resembling the Paris beer. By fermenting the saccharized starch with the honey of Brittany instead of hops, he obtained a palatable liquor that had all the qualities of the beer of Louvaine.

In fact, potato starch is almost tasteless, and seems capable of being flavoured in fermentation with any substance that gives a peculiar character either to our beers or home-made wines. I hope shortly to be able to report the result of some experiments undertaken to ascertain its applicability to these domestic manufactures.

E. B. S.